Title: The Playground Dilemma

Brief Overview:

Students will gain an understanding of the concept of finding area of a designated shape. They will improve their ability to use instruments of measurement and formulas to analyze and solve mathematical problems pertaining to area. Students will apply their knowledge of finding area to a real-life situation, and they will create, organize, and communicate how mathematical ideas build on one another to produce a coherent whole.

Links to NCTM 2000 Standards:

- **Standard 2: Patterns, Functions, and Algebra**
  Mathematics instructional programs should include attention to patterns, functions, symbols, and models so that all students use symbolic forms to represent and analyze mathematical situations and structures; and use mathematical models and analyze change in both real and abstract contexts.

- **Standard 3: Geometry and Spatial Sense**
  Mathematics instructional programs should include attention to geometry and spatial sense so that all students select and use different representational systems, including coordinate geometry and graph theory; and use visualization and spatial reasoning to solve problems both within and outside of mathematics.

- **Standard 4: Measurement**
  Mathematics instructional programs should include attention to measurement so that all students understand attributes, units, and systems of measurement; and apply a variety of techniques, tools, and formulas for determining measurements.

- **Standard 6: Problem Solving**
  Mathematics instructional programs should focus on solving problems as part of understanding mathematics so that all students build new mathematical knowledge through their work with problems; develop a disposition to formulate, represent, abstract, and generalize in situations within and outside mathematics; apply a wide variety of strategies to solve problems and adapt the strategies to new situations; and monitor and reflect on their mathematical thinking in solving problems.

- **Standard 8: Communication**
  Mathematics instructional programs should use communication to foster an understanding of mathematics so that all students organize and consolidate their mathematical thinking to communicate with others; express mathematical ideas coherently and clearly to peers, teachers, and others; extend their mathematical knowledge by considering the thinking and strategies of others; and use the language of mathematics as a precise means of mathematical expression.

- **Standard 9: Connections**
  Mathematics instructional programs should emphasize connections to foster an understanding of mathematics so that all students recognize and use connections among different mathematical ideas; understand how mathematical ideas build on one another to produce a coherent whole; and recognize, use, and learn about mathematics in context outside of math.

- **Standard 10: Representation**
  Mathematics instructional programs should emphasize mathematical representations to foster an understanding of mathematics so that all students create and use representations to organize, record and communicate mathematical ideas.

Grade/Level:

Grade Five

Duration/Length:

This unit takes approximately 3 class periods of 45 to 60 minutes long and one class period for assessment.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Using and reading a ruler
- Multiplying and dividing
- Understanding maps and scale
- Constructing models
- Beginning understanding of area
- Persuasive letter writing

Student Outcomes:

Students will:

- define area.
- work cooperatively with others.
- demonstrate their ability to solve problems related to area.
- solve problems using a variety of strategies.
- design maps on grid paper.
- create three-dimensional models from reading maps on grid paper.

Materials/Resources/Printed Materials:

- Ruler
- Coffee stirrers, pipe cleaners
- Pencils and writing journals
- Coloring utensils
- Student resource sheets (included)
- 1 large piece of cardboard or poster board (to be used for 3-D model of playground)
- Scissors
- Overhead/transparency pens/transparencies of student resource sheets
- Vignette (included)
- Blank paper
- 1/4 in. grid paper (included)
- Construction paper (8 x 11 any color)
- Scoring Rubric (included)

Development/Procedures:

Day 1:

- Make a transparency of Teacher Resource 1. Display it to the students and allow them to read the vignette silently. Ask the students to brainstorm ideas about how they might solve the problem stated.
- Help the students to formulate the idea that the proper playground equipment can motivate children to play constructively during recess, while also forming healthy attitudes about their free time.
- Take the students out to the existing playground and have them sketch it. Have students take rulers, yardsticks, or measuring tapes to measure the equipment so that it can be sketched to scale on grid paper. Measurements should cover all playground equipment, special sports fields, and the overall size of the playground including asphalt and grassy areas.
- To demonstrate the intent of the map of the existing playground, display a previously prepared transparency (not included) of an imaginary playground, including equipment, to show the students the proper procedure for drawing the playground to scale.
- At this point, the teacher explains the concept of surface area as being the inside region of a space or figure. In this case, the area will be the rectangular space each piece of equipment occupies. Explain that one may either count the squares on a grid to determine the area, or they may multiply length by width and achieve the same results.
- Distribute Student Resources 1a, 1b, and 2. Tell the students they will need to use the formula for finding area (Length x Width = Area) and Student Resources 1a and 1b to complete the chart on Student Resource 2. Given pictures of playground equipment with measurements, the students will compute the area of the items and record it on the chart.
- The teacher will model this procedure by choosing one of the pieces of equipment, finding the area of that item, and then charting the data on Student Resource 2.
- After this demonstration, the students will be asked to complete the remaining problems independently.

Day 2:

- Review the definition and formula for finding area. (Encourage students to use proper
- math vocabulary.)
- In pairs, have students explain the thinking processes used to complete the independent
- practice from the previous day (Student Resources 1a, 1b, and 2).
- The teacher will display a grid transparency and explain the scale as 1/4 in. or 1 square = 1 ft.
- The teacher will now select a piece of playground equipment and demonstrate how to graph it onto a grid transparency. The teacher will show students how to use their knowledge of finding the area (L x W = A) to transfer their independent practice, Student Resource 2, to visual representation (grid transparency). Encourage students to ask questions to gain clarification.
- Explain the task to students. The students will be required to design their playground on the grid paper and label and color all equipment. Note: Students should be advised to draw and label the equipment inside the area region.
- The teacher should make a chart of the following criteria and discuss the potential impact it will have on the student's 'personal' playground.
    1. Each playground may include equipment for each grade.
    2. The existing baseball field may not be moved.
    3. The playground may be divided into a grassy section and an asphalt section.

4. You may have no more than two of the same pieces of equipment on the playground. The baseball field may not be included in your three pieces of equipment.

- Distribute 1/4 in. grid paper, Student Resource 3. The students will refer to Student Resources 1a, 1b and 2 to repeat what was previously modeled.
- Journal writing: "Explain the ideas you had while trying to place your equipment."
  "What problems did you encounter?"
  "How did your understanding of area help you solve the problems?"
  "Why did you choose to place the equipment where you did?"
  "Would your playground have to be changed to meet the criteria; if so what would you change?"

Day 3:

- The students will share their playgrounds with the class.
- The teacher will evaluate students' understanding of area orally. (Allow one student to give the length and width of an object, and the rest of the class should calculate the object area).
- Using the graph paper playground, the students will create their 'personal' playground by cutting and pasting the playground equipment onto a piece of construction paper using the four criteria stated.
- Journal writing: "How did you decide what three pieces of equipment to use?"
  "How did you use your knowledge of area to arrange the playground?"

Performance Assessment:

Day 4:

- The teacher will demonstrate how to construct 3-D objects such as a cube by connecting coffee stirrers with pipe cleaners. See Teacher Resource 3.
- The teacher will divide the students into cooperative groups of 4 or 5 and assign duties. Have the materials manager distribute the coffee stirrers, pipe cleaners, rulers and cardboard, and poster board or tag board. Allow the students to practice connecting the materials to form shapes in 2-D and 3-D. Teacher's assistance may be required with some groups.
- Teacher should display a copy of the criteria on a chart and discuss the criteria:
  1. Each playground may include equipment for each grade.
  2. The existing baseball field may not be moved.
  3. The playground may be divided into a grassy section and an asphalt section.
  4. You may have no more than two of the same piece of equipment. The baseball field may not be included in your four or five pieces of equipment.
- Have 'measurer' use the ruler to draw the baseball field on the poster board in the upper right hand corner. The teacher should give the students the measurements for the baseball field based on their use of cardboard, poster board, or tag board.
- Tell the students to construct 3-D shapes to represent the equipment on a group-designed model playground.
- Have students arrange their model playground for display. Allow students to critique each group's work.
- Read writing prompt, Teacher Resource 4, aloud and have students respond independently.

Extension/Follow Up:

- Create a survey chart of the top three pieces of playground equipment and have students graph the data.
  Change the shape of the playground so that it is no longer a rectangle or so that it is a smaller rectangle.
- Develop a price list chart. Allow students to use it to do comparison shopping and decide where to purchase their playground equipment for the lowest cost.

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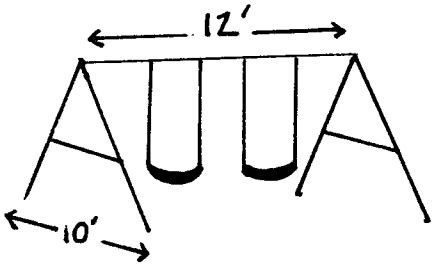
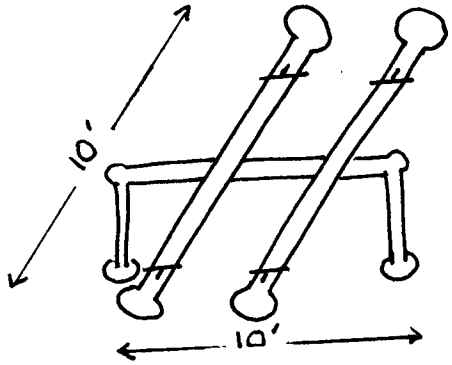
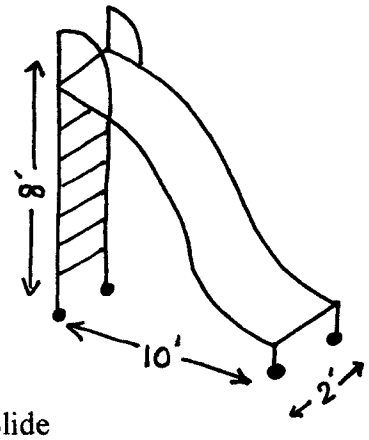


Swing Set

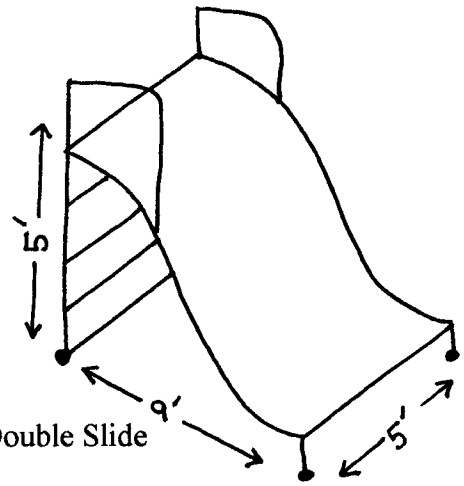


See Saw

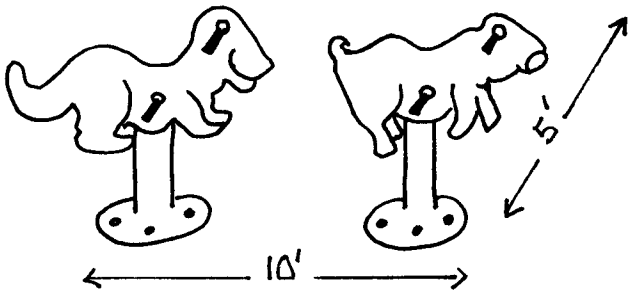
Student Resource1a



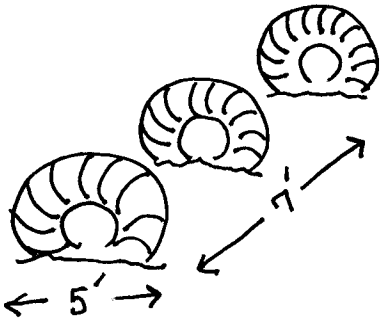
Slide



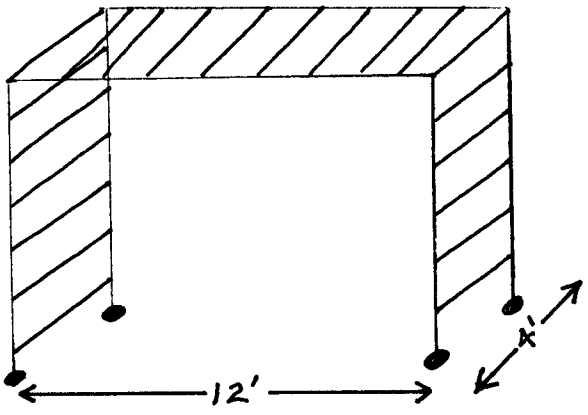
Double Slide



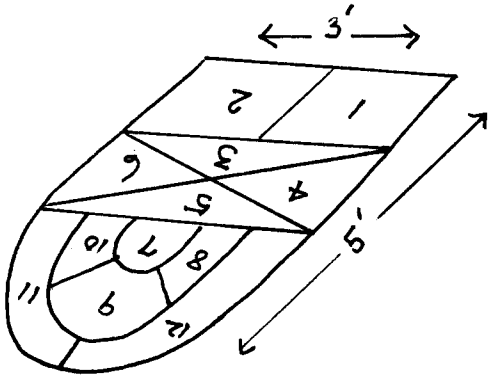
Rocking Animals



Sunken Tires

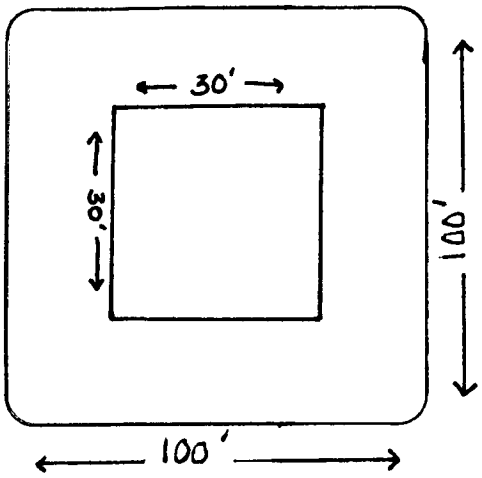


Monkey Bars



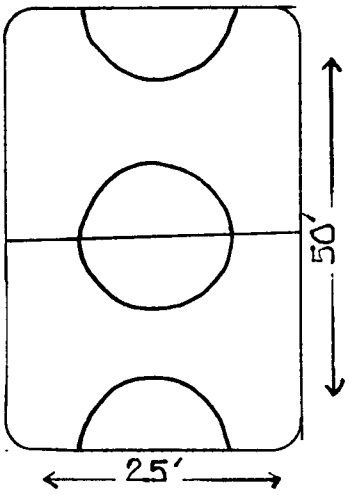
Hopscotch

Student Resource1b

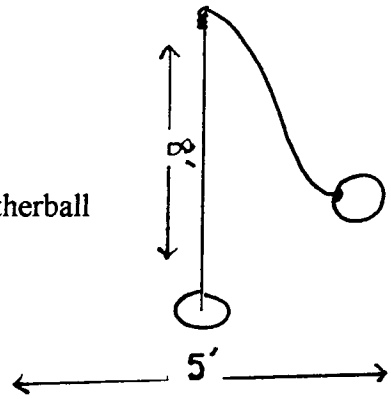


Baseball Field

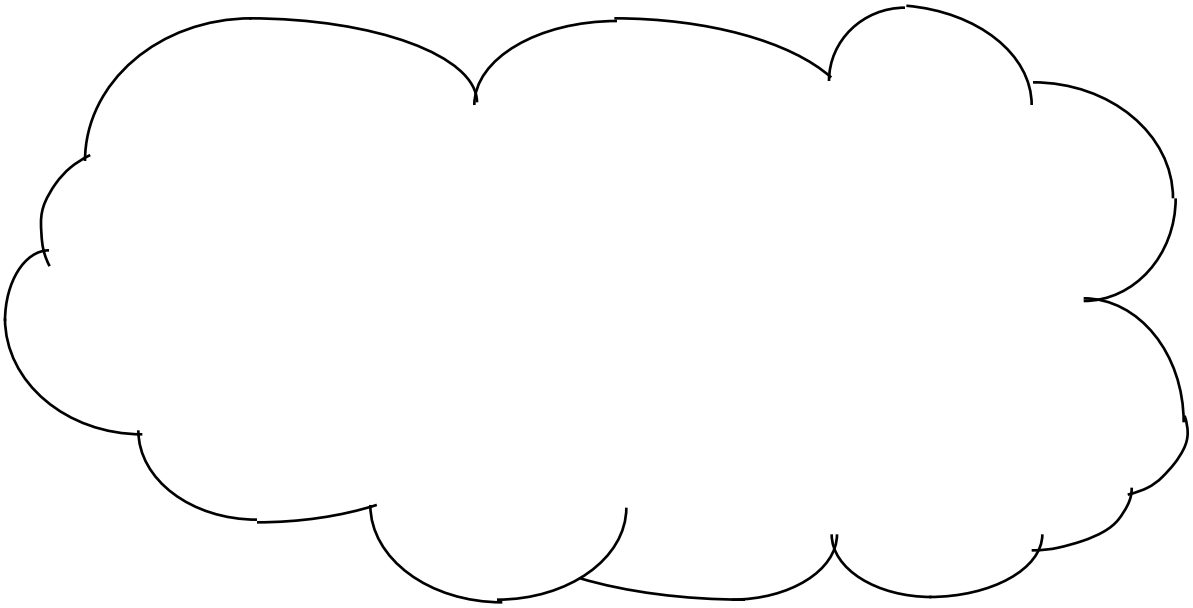
Basketball Court

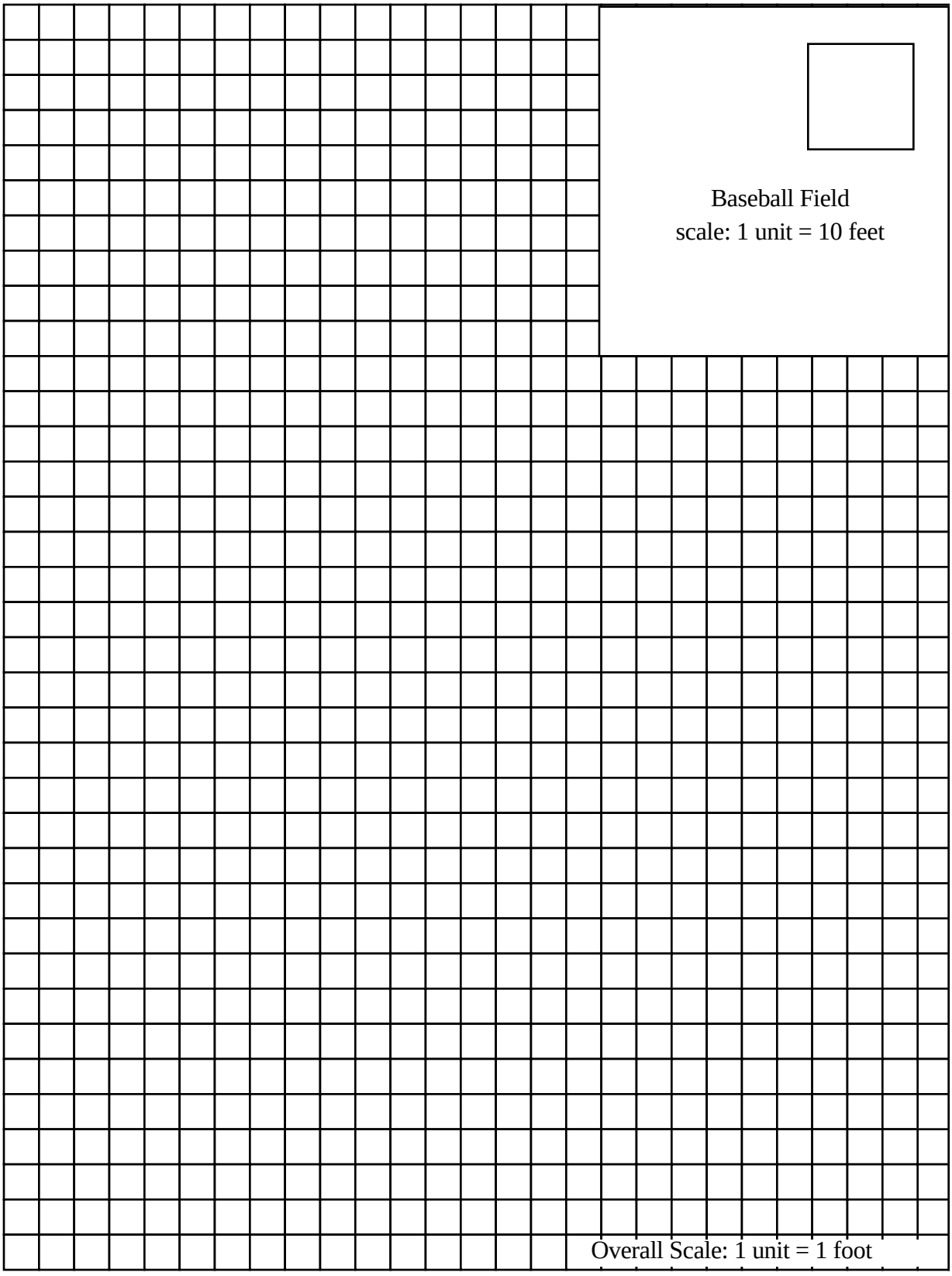


Tetherball



Equipment	Length	Width	Area




Baseball Field
scale: 1 unit = 10 feet
Overall Scale: 1 unit = 1 foot

The Playground Dilemma

Vignette

The Board of Education has determined that children who are physically healthy perform better in the classroom. One way to promote physical health is to ensure that all elementary school students have play equipment on their playground. Our class has been asked to help the Board by evaluating the existing playground, determining what should be added, and deciding what can be added based on the available space.

The Playground Dilemma
Answer Key

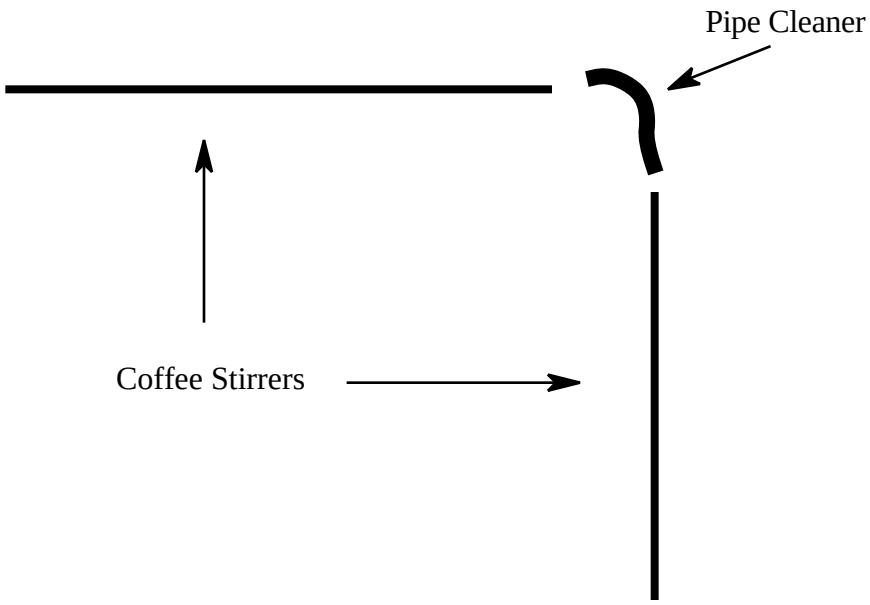
Equipment	Length	Width	Area
Swingset	12’	10’	120 sq. ft.
Seesaw	10’	10’	100 sq. ft.
Slide	10’	2’	20 sq. ft.
Double Slide	9’	5’	45 sq. ft.
Rocking Animals	10’	5’	50 sq. ft.
Tires	7’	5’	35 sq. ft.
Monkey Bars	10’	4’	40 sq. ft.
Hopscotch	3’	5’	15 sq. ft.
Baseball Field	100’	100’	10,000 sq. ft.
Basketball Court	25’	50’	1,250 sq. ft.
Tetherball	5’	8’	40 sq. ft.

Coffee Stirrer Construction

To construct the group playgrounds, each group will need a package of coffee stirrers, 1 inch pieces of pipe cleaners (may be cut previously to this activity or by the children at the time of construction), and a pair of scissors. The coffee stirrers may be cut to accommodate the shapes that need to be formed.

To connect the stirrers to the pipe cleaners, one or two pieces of pipe cleaners may be placed in one end of a stirrer, and then, using the other end of the pipe cleaner, connect another stirrer. Since the pipe cleaner is flexible, this will allow the students to bend and shape their figures to make the shapes they desire. One piece of pipe cleaner will connect two stirrers, whereas two will create a three-way connection to create a 3-D shape.

This same procedure will allow the students to create the equipment they want to have on their model playground.



The Playground Dilemma

Writing Prompt

Today you will be writing a letter to persuade your principal that your group's playground design is one that all students in your school will enjoy. Your letter should:

1. Tell why the school needs to change the existing playground to the design that your group has constructed.
2. Explain the thinking your group used to finalize the design of the playground.
3. Tell why your group believes that all students will enjoy the playground that your group constructed.

The Playground Dilemma
Scoring Guide

Use this rubric to score the area of the playground equipment, Student Resource 2:

4 Area is calculated correctly for all 12 pieces of equipment.

3 Area is calculated correctly for 9 pieces of equipment.

2 Area is calculated correctly for 6 pieces of equipment.

1 Area is calculated correctly for 3 pieces of equipment.

0 Area is calculated correctly for less than 3 pieces of equipment.

Use this rubric to score the 'personal' playground on the construction paper:

4 Student included three pieces of equipment. No more than two pieces are the same. All items are labeled.

3 Student included three pieces of equipment. No more than two pieces are the same. One item is not labeled.

2 Student included less than three pieces of equipment. Two items are not labeled.

1 Student included three pieces of equipment. No items are labeled.

0 Student's work does not reflect any portion of directions that were assigned.

Use this rubric to score the writing prompt, letter to the principal (Teacher Resource 4).

4 Student uses proper friendly letter format. Student responds to all items in the writing prompt. Student demonstrates good clear reasoning by referring to the information given in the vignette and the criteria given in the directions for Day 4. Student uses appropriate vocabulary and good word choice to express and clarify ideas. The student's ideas are clearly and concisely stated. Student uses a variety of sentences. Student writing contains few grammatical, mechanical, or spelling errors.

3 Student uses proper letter format. Student responds to at least 2 items in the writing prompt. Student demonstrates good, clear reasoning by referring to <u>either</u> the information given in the vignette <u>or</u> the criteria given in the directions for Day 4. Student uses appropriate vocabulary, <u>but</u> word choice is not very good. Student's ideas are clearly stated. Student uses some variety of sentences. Student's writing might have been a '4', <u>but</u> the writing has numerous grammatical, mechanical, or spelling errors.

2 Student's letter format contains errors. Student responds to at least 2 of the items in the writing prompt. Student demonstrates reasoning, but does not refer to either the information given in the vignette or the information given in the directions for Day 4. Student does not use appropriate vocabulary, and word choice is poor. Student's ideas are not clearly stated. Student's writing is stiff and choppy. Student's writing has numerous grammatical, mechanical, or spelling errors.

1 Student's letter format contains errors. Student responds to only 1 item on the writing prompt. Student demonstrates little reasoning and does not refer to the information given in the vignette or the information given in the directions for Day 4. Student does not use appropriate vocabulary, and word choice is poor. Student's writing is stiff and choppy. Student's writing has major grammatical, mechanical, or spelling errors.

0 Student makes no attempt to write a letter or did not respond to the items in writing prompt.

The Playground Dilemma

Extension Data Analysis

After examining the playgrounds that your class has made in cooperative groups, the Board of Education is ready to provide you with the money needed to purchase new equipment. However, they are concerned that the model playground may not contain equipment for all grade levels. Your class decides to conduct a survey to ensure that equipment is available for all grade levels. The results of your survey are displayed on the chart below.